PARASITISM OF EUROPEAN CORN BORER BY *LYDELLA THOMPSONI* (DIPTERA: TACHINIDAE) AND *MACROCENTRUS GRANDII* (HYMENOPTERA: PYRALIDAE) IN SOUTHEAST PENNSYLVANIA AND DELAWARE[1]

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ABSTRACT: After *Lydell thompsoni* (Diptera: Tachinidae), a parasitoid of the European corn borer (ECB), *Ostrinia nubilalis* (Lepidoptera: Pyralidae), disappeared in the 1960's, it was successfully reintroduced in Delaware in the mid-1970's as a potential regulating agent against populations of this very important pest. In 1981 and 1982, the flies were recovered from ECB larvae at 15 different sites in six southeast Pennsylvania counties. This species, along with *Macrocentrus grandii* (Hymenoptera: Braconidae), were found to exert an average of 17.5% parasitism of ECB. Of the two parasitoids, *M. grandii* had the higher percentage parasitism. A correlation analysis of the data, on a site by site basis, revealed a significant negative interaction (r=-0.86) between populations of these two parasitoid spp.

The European corn borer (ECB) *Ostrinia nubilalis* (Hübner) (Lepidoptera: Pyralidae) is an important pest of corn and other crops in Pennsylvania and other regions. In Delaware it is considered the most important pest (MacCreary and Rice 1949, Milliron 1958, Van Denburgh et al. 1962). According to annual surveys in Delaware it has had a sporadic increase in numbers since 1934 reaching 707 borers/100 corn plants in 1977 (Burbutis et al. 1984). In Pennsylvania, ECB is considered a threatening insect (J. McGehan, personal communication).

Efforts to control the ECB biologically in the U.S. are documented by Burbutis et al. (1984). Of the 6 parasitoids considered "permanently established" by Baker et al. (1949), *Lydella thompsoni* Herting (= *Lydella stabulans grisescens* Robineau-Defroidy) (Diptera: Tachinidae) was described as the most effective and widely spread. *L. thompsoni* was established in many states, including Pennsylvania (Rolston et al. 1958, Cory et al. 1952, Van Denburgh et al. 1962) but has experienced population declines requiring reintroduction several times. Peairs and Lilly (1975) reported that *L. thompsoni* disappeared from other northeastern states.

L. thompsoni was introduced into Delaware in 1974-76, and recent

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recoveries indicate its successful establishment in all three counties (Burbutis et al. 1981, 1984).

This study was initiated to evaluate the presence of *L. thompsoni* in Pennsylvania, its possibe dispersal from the original release sites in Delaware, and to assess its status, along with other parasitoids, relative to control of ECB in the areas surveyed.

METHODS

In late 1981 ECB larvae were collected from corn by hand dissection of stalks in fields from five Pennsylvania townships bordering New Castle County, DE. Approximately 40 larvae from each site were incubated in the laboratory and percentage parasitism data were calculated on the basis of the number of emerged adult parasites. In 1982, ECB larvae were collected from sites about 10-20 miles apart along three transects running north, northwest, and west into Pennsylvania from a point near Wilmington, DE. (Fig. 1) ECB larvae were either dissected or incubated in the laboratory. An earlier study showed that there is no significant difference between dissection or incubation for monitoring *L. thompsoni* parasitism (Burbutis et al. 1984). The laboratory data plus the number of live field-collected *L. thompsoni* puparia were used to calculate percentage parasitism. Larvae were collected through the fall and winter of 1982 and into the spring of

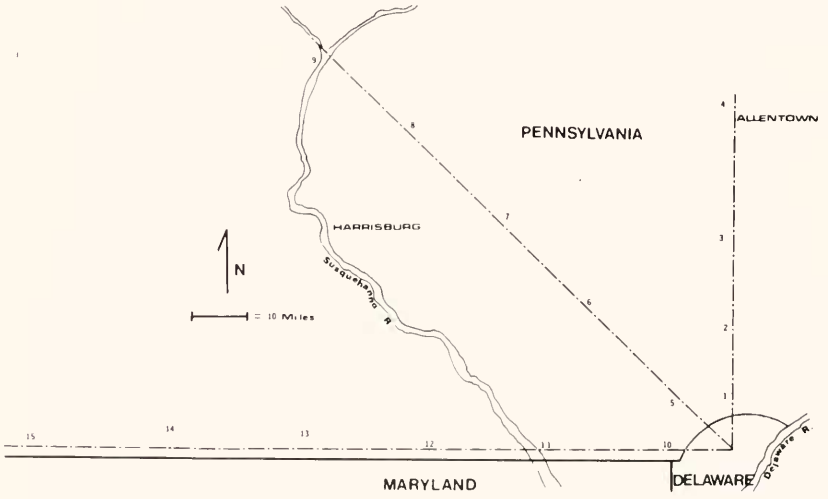

Fig. 1. Map of southeast Pennsylvania showing transects from Wilmington, Delaware, and sites sampled for European corn borer parasites in 1982-83. Numbers indicate sampling sites: 1) West Chester, 2) Lionville, 3) Pottstown, 4) Allentown, 5) Unionville, 6) Kinzers, 7) Schaefferstown, 8) Lickdale, 9) Selinsgrove, 10) Strickersville, 11) Wakefield, 12) Stewartstown, 13) Hanover, 14) Gettsburg, 15) Waynesboro.

1983. Similar methods were used for ECB larvae collection and parasitism monitoring in southeastern Pennsylvania during the fall of 1969 and winter of 1970.

RESULTS AND DISCUSSION

Parasitism data for 1981 (Table 1) showed the two prominent insect parasitoids of ECB in this region to be *L. thompsoni* and *Macrocentrus grandii* Goidamich (Hymenoptera: Broconidae), with the highest combined parasitism (36.3%) in London Britain Township, PA, located west of Wilmington, DE. Of the two, *M. grandii* showed the greater percentage parasitism in all five townships sampled. *L. thompsoni* was recovered from all sites except one, and appeared to be well established.

Results from the 1982 growing season (Table 2) revealed both *M. grandii* and *L. thompsoni* to be established throughout the transects, with *M. grandii* continuing to average a higher level of parasitism. This was also the case in the study by Burbitis et al. in Delaware (1981). *M. grandii* was present in all but one of the 13 sites surveyed. The maximum percentage parasitism (28.3%) by *M. grandii* was found at Gettysburg in Adams County, PA. The higher level of parasitism by *M. grandii* may be because *L. thompsoni* has not become fully adapted since its reintroduction. Also, it

Table 1. *Lydella thompsoni* and *Macrocentrus grandii* in overwintering European corn borer larvae from Pennsylvania locations adjacent to Delaware; fall 1981/winter 1982 and fall 1969/winter 1970.

		Parasitism by:			
	Number of ECB larvae collected	*L. thompsoni*		*M. grandii*	
1981/82		No.	%	No.	%
London Britain	55	8	14.5	12	21.8
New Garden	29	2	6.9	3	10.3
Kennett	37	1	2.7	3	8.1
Birmingham	41	2	4.9	8	19.5
Thornbury	42	0	0	4	9.5
1969/70					
New London	95	0	—	32	33.7
Lenape	88	0	—	12	13.6
West Chester	117	0	—	23	19.7
Parkesburg	124	0	—	31	25.0
Little Britain	117	0	—	32	27.4

may not be able to successfully compete with *M. grandii* which has been established in the area for considerable time. The relatively high level of parasitism by *M. grandii* in the absence of *L. thompsoni* in southeastern Pennsylvania during fall 1969/winter 1970 also lends support to this idea (Table 1).

L. thompsoni was found 30 miles north of Wilmington, but was not recovered from two collection sites (nos. 3 and 4) north of the Schuylkill River in Berks or Lehigh counties in 1982. Along the west transect, this insect was recovered from four sites, two of which were west of the Susquehanna River, but it was not collected at either the Gettysburg or Waynesboro sites (nos. 14 and 15). *L. thompsoni* was found at all collecting sites along the northwest transect as far as Selinsgrove (site no. 9) in Snyder County, a site about 100 miles from Wilmington. Greater precision in establishing the distribution of *L. thompsoni* in Pennsylvania will require more thorough sampling in future years.

While the percentage of parasitism of *L. thompsoni* from the last two sites in the Northwest transect appear relatively low (3.5% and 2.0%), we note that both of these sites represented late (April 23 and 29) collection of larvae, and in both cases the data are from *L. thompsoni* puparia. It is likely that some adult flies had already emerged and therefore the real parasitism rate was actually higher than found in those sites in 1982.

Although documentatin of the presence of *L. thompsoni* in southeastern Pennsylvania does not prove that these populations resulted from the reintroductions made in Delaware in recent years, circumstantial evidence strongly suggests that the source is most likely from the release made in that state during 1974-76 (Burbutis et al. 1981, 1984). Extensive surveys in Delaware, involving the collection of about 16,000 mature overwintering ECB larvae, resulted in no *L. thompsoni* recovery during the years 1961-77 (Burbutis et al. 1984). If a latent population had occurred in southeastern Pennsylvania during this time, it is likely that some *L. thompsoni* would have been recovered in Delaware, especially since the state average ECB fall population peaked at 707 borers/100 plants in 1977 (Burbutis et al. 1984) thus providing an abundant resource for parasites. Furthermore, ECB larvae collections during fall 1969/winter 1970 in southeastern Pennsylvania corn fields resulted in no recoveries of *L. thompsoni* (Table 1). Also, *L. thompsoni* is known to have disappeared elsewhere (i.e., Connecticut during October 1978-April 1981 (Andreadis 1982), in Nebraska during fall 1966-fall 1976 (Hill et al. 1978) and the Corn Belt States, Hill et al. (1973)). It appears most likely that the population of *L. thompsoni* sampled in southeastern Pennsylvania during this study originated from the 1974-76 reintroductions in Delaware.

L. thompsoni was first recovered from overwintering ECB at the 1974-

Table 2. Fall 1982-Winter 1983 summary of European borer parasitism from Pennsylvania transects.

Site	Number of[1] borers collected	Non-parasitic deaths	*L. thompsoni* puparia found in field	*L. thompsoni* reared or dissected	Number of borers with *M. grandii*	Percent parasitism *L.t.*	*M.g.*	Total
North transect								
West Chester[2]	113	0	0	12	3	10.6	2.7	13.3
Lionville	63	11	1	6	2	13.2	2.7	16.4
Pottstown[3]	110	0	0	0	—	0	0	0
Allentown[3]	103	0	0	0	—	0	—	0
Northwest transect								
Unionville	47	0	0	1	7	2.1	14.9	17
Kinzers	49	0	0	3	10	6.1	20.0	26.1
Schaefferstown	69	0	0	3	11	4.3	15.9	20.2
Lickdale	57	0	2	0	7	3.5	12.3	15.8
Selinsgrove	51	1	1	0	9	2.0	18.0	20
West transect								
Strickersville	40	0	0	5	0	12.5	0	12.5
Wakefield[2]	126	5	1	7	1	6.6	0.8	7.4
Stewartstown	54	0	0	7	1	12.9	1.9	14.8
Hanover	109	16	4	5	6	9.7	6.5	16.2
Gettysburg	106	0	0	0	30	0	28.3	28.3
Waynesboro	50	0	0	0	10	0	20.0	20.0
					$\bar{x}$=	7.6	12.04	17.5

[1]Includes any *L. thompsoni* found in field; Each pupariam counted as one borer.
[2]*L. thompsoni* parasites determined by dissection only.
[3]*L. thompsoni* parasites determined by dissection (50%) and rearing (50%). *M. grandii* could not be discerned by dissection.

76 release sites in Delaware during September 1978 and some were collected 33 miles from the release site (FRS) in March 1979 (Burbutis et al. 1981). The most distant Delaware collection in the fall of 1979 was Summit Bridge (55 miles FRS) and in 1980 it was Newark (66 miles FRS) (Table 3). *L. thompsoni* was well established in the southeastern corner of Pennsylvania (78 miles FRS) by the fall of 1981 (Table 1). The most distant site in 1982 was Selinsgrove (Table 2). In the fall of 1983, an empty puparial case was found in an ECB cavity in field corn at a site near Hancock, Maryland (Romig and Mason unpublished data), indicating the presence of *L. thompsoni* in that state. These latter two findings are about 190 air miles from the 1974-76 release site in Delaware. Based on the assumption that *L. thompsoni* collected in this study originated from the 1974-76 releases in Delaware, the aforementioned information suggests that the dispersal rate of this fly over an 8-year period is an average of at least 20 miles/year. This is about 10 times greater than that reported by Van Denburgh et al. (1962) and Mac Creary and Rice (1949). However, they were working in areas within a few miles of the release sites and reported on data taken within 1 or 2 years after releases. These and our studies suggest that dispersal rate is limited to a few miles within the first two years following release, but after *L. thompsoni* populations become well established, dispersal rate can increase to more than 25 miles/year.

An analysis of the 1982 data suggested a possible negative interaction between populations of *M. grandii* and *L. thompsoni.* At sites where the population of *M. grandii* was high, fewer *L. thompsoni* were recovered. When pairing the data in a step-wise fashion from each site, a significant ($p < 0.01$) negative correlation value ($r=-0.86$) was found). Analysis of the Delaware parasitism data (Table 3) fails to confirm the strong negative correlation observed in Pennsylvania. Of 51 samples where one or both parasitoids were present, only 11 have percentages amounting to greater than 50% of its paired variate and 19 showed the presence of one species but the absence of the other. This degree of variation in the Delaware data could bias the correlation analysis and it is possible that increased sample size would reveal the same kind of relationship observed in the Pennsylvania data. Environmental differences between Delaware and Pennsylvania may be responsible for the observed differences, but the strength of the negative relationship is too great to be ignored. Further field and laboratory tests should be made to determine if such an interaction is real and if so, whether it involves agonistic behavior, competition for accessible food resources (ECB larvae), or other ecological factors. Also it would be interesting to determine if this interaction may have contributed to the supression of *L. thompsoni* populations (i.e. competitive displacement) in the past several decades.

Table 3. Percent parasitism of European corn borer by *Lydella thompsoni* and *Macrocentrus grandii* in Delaware, fall 1979 and fall 1980.

	Percent Parasitism			
	1979		1980	
Location	*L. thompsoni*	*M. grandii*	*L. thompsoni*	*M. grandii*
New Castle Co.				
N. Smyrna	6	24	2	0
Townsend	2	20	14	2
Armstrong	10	9	4	2
Bay View	14	30	2	0
Summit Bridge	7	18	2	0
Tybouts Corner	—	—	3	0
Newark	0	24	6	0
S. Yorklyn	—	—	0	0
Montchanin	—	—	0	0
Arden	—	—	0	0
Kent Co.				
Felton	5	8	7	11
Hollandsville	3	17	5	2
Farmington	3	10	0	6
Milford	5	14	0	2
Thomsonville	8	0	3	15
Postles Creek	17	23	2	15
Little Creek	27	33	5	20
Pearsons Corner	11	11	4	2
Clayton	15	13	5	0
Woodland Beach	2	17	26	0
Sussex Co.				
Bridgeville	3	17	2	0
Seaford	5	3	0	0
Mt. Pleasant Church	3	9	2	12
Pepper	0	16	0	2
Gumboro	2	2	0	2
Roxanna	5	14	0	0
Angola	0	15	14	10
Reddin	3	5	2	4
Milton	3	16	0	6
Lincoln	3	16	0	0

CONCLUSIONS

In 1982, both *M. grandii* and *L. thompsoni* were established widely throughout southeast Pennsylvania, with combined parasitism averaging 17.5%. *M. grandii* is the predominant insect parasite of ECB in this region, averaging 12% and ranging up to 28.3% parasitism. *L. thompsoni* parasitism averages 7.6% in this region with a high of 12.9%.

Pennsylvania counties in which *L. thompsoni* were found are: Chester, Lancaster, York, Delaware, Lebanon, and Snyder. It is likely that they are to be found also in Berks, Cumberland, and Dauphin Counties as well as others. Combined percentage parasitisms, running frequently in the teens and twenties, show that these two parasitoids are probably important biological control agents of an important pest in this region.

LITERATURE CITED

Andreadis, T.G. 1982. Current status of imported and native parasites of the European corn borer in Connecticut. J. Econ. Entomol. 75: 626-629.

Baker, W.A., W.G. Bradley, and **C.A. Clark.** 1949. Biological control of the European corn borer in the United States. U.S.D.A. Tech. Bull. 983. 185 p.

Brindley, T.A., and **F.F. Dicke.** 1963. Significant development in European corn borer research. Ann. Rev. Entomol. 8: 155-76.

Burbutis, P.P., N. Erwin, and **L.R. Ertle.** 1981. Reintroduction and establishment of *Lydella thompsoni* and notes on the parasites of European corn borer in Delaware. Environ. Entomol. 10: 799-81.

Burbutis, P.P., C.E. Mason, and **R.F. Romig.** 1984. European corn borer (Lepidoptera: Pyralidae) and its parasiotid *Lydella thompsoni* (Diptera: Tachinidae) in Delaware. J. Kans. Entomol. Soc. 57(3): 394-399.

Cory, E.N., H.S. McConnell, K.D. Arbuthnot, and **D.W. Jones.** 1952. Parasites of the European corn borer in Maryland. Maryland Agric. Exp. Res. Bull. A72. 13 p.

Hill, R.E., D.P. Carpino, and **Z.B. Mayo.** 1978. Insect parasites of the European corn borer, *Ostrinia nubilalis,* in Nebraska from 1948-1976. Environ. Entomol. 7: 249-253.

Hill, R.E., H.C. Chiang, A. Keaster, W.B. Showers, and **G.L. Reed.** 1973. Seasonal abundance of the European corn borer, *Ostrinia nubilalis,* within the North Central States. Nebraska Agric. Exp. Stn. Res. Bull. 255. 82 p.

MacCreary, D., and **P.L. Rice.** 1949. Parasites of the European corn borer in Delaware. Ann. Entomol. Soc. Am. 42: 141-53.

Milliron, H.E. 1958. Economic insect and allied pests of Delaware. Del. Agric. Exp. Res. Bull. 321, 87 p.

Peairs, F.B., and **J.H. Lilly.** 1975. Parasites reared from larvae of the European corn borer, *Ostrinia nubilalis* (Hbn), in Massachusetts, 1971-73. J.N.Y. Entomol. Soc. 83: 36-37.

Rolston, L.H., C.R. Neiswander, K.D. Arbuthnot, and **G.T. York.** 1958. Parasites of the European corn borer in Ohio. Ohio Agric. Exp. Stn. Res. Bull. 819. 36 p.

Van Denburgh, R.S., P.P. Burbutis, and **G.T. York.** 1962. The reintroduction and recovery of *Lydella stabulans grisescens,* a parasite of the European corn borer in Delaware. J. Econ. Entomol. 55: 11-14.